REMARKS

Applicants wish to direct the Examiner's attention to MPEP § 2131 which states that to anticipate a claim, the reference must teach every element of the claim.

> "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). "The identical invention must be shown in as complete detail as is contained in the ... claim." *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed Cir. 1989). The elements must be arranged as required by the claim, but this is not an *ipsissimis verbis* test, i.e., identity of terminology is not required. *In re Bond*, 910 F.2d 831, 15 USPQ2d 1566 (Fed.Cir. 1990).

Applicants most respectfully submit that each claim limitation is not shown in the reference as required and as more fully described as follows. However, should the Examiner not agree, the Examiner is invited to contact the undersigned attorney to arrange an interview in an effort to determine what if any additional amendments may be necessary to place the application in condition for allowance including the possibility for filing a further amendment with an RCE.

Claim Rejections - 35 USC §102(b)

The examiner in charge rejected claims 5 to 7 under 35 U.S.C. 102(b) as being anticipated by Araki et al. (US Pat. 5,821,500) (hereinafter, referred to as "cited reference 1").

Grounds for claim rejections presented by the examiner in charge are as follows:

It is urged in the Official Action that Araki et al. discloses a process for manufacturing a welding wire and the welding wire obtained from such a process. The

wire is subjected to an optimal heat treatment in order to modify the hardness. The wire is drawn to 2 to 4 mm in diameter with a hardness of the outer skin controlled to a Vickers hardness of 180 to 250 Hv. The raw wire has a hardness of 150 to 250 Hv.

Response to Claim Rejections - 35 USC §102(b)

The present invention relates to a wire for arc welding, and more particularly to a wire for arc welding, which has enhanced feedability by uniformly distributing residual stress of the final wire product.

On the other hand, cited reference 1 relates to a flux-cored welding wire for low-hydrogen welding having superior resistance to cracking and primer-proof quality suited for use in the welding of high-tensile steels and other high-grade steels.

Comparison between the present invention and cited reference 1 in terms of object, construction, and effect will now be made in detail.

1. Object

It is a first object of the present invention to enhance the feedability of a wire for arc welding by uniformly distributing an internal stress of the wire through adjustment of the hardness deviation of a cross section and in a longitudinal direction of the wire in the wire drawing process.

A second object of the present invention is to provide a wire for arc welding having a uniform distribution of residual stress of the wire by controlling an contact area in which the wire is in contact with dies, and by reducing hardness deviation of the wire.

A third objection of the present invention is to provide a method of drawing a wire for arc welding which is capable of reducing hardness deviation of the wire.

In a conventional wire drawing process, the surface of the wire is hardened, and the dies are abraded. Consequently, wire feeding is not smoothly carried out in the course of welding. Furthermore, the residual stress of the wire is irregularly distributed with the result that the wire is severely twisted in the course of feeding the wire.

On the other hand, it is an object of cited reference 1 to manufacture a flux-cored welding wire for low-hydrogen welding having superior resistance to cracking and primer-proof quality suited for use in the welding of high-tensile steels and other high-grade steels.

The conventional commonly used bell and tunnel furnaces are not completely satisfactory because productivity of bell furnaces is low, thermal efficiency of tunnel furnaces is low, and the material, structure and service life of tunnel furnaces do not permit use especially at temperature higher than 800°C. Furthermore, the conventional single-step heat treatment is not completely satisfactory because not only hydrogen-induced cracks are formed, but also gas grooves, pits and other weld defects are formed.

As can be seen from the above-mentioned comparison between the present invention and cited reference 1 in terms of object, the present invention is quite different from cited reference 1 in that the object of the present invention is to enhance the feedability of the wire for arc welding by uniformly distributing the internal stress of the wire, whereas the object of cited reference 1 is to provide a wire for low-hydrogen welding having superior resistance to cracking and primer-proof quality by applying optimum heating in two processes, instead of the conventional single heating. This differences are reflected in the claims.

The present invention is characterized by reducing hardness deviation of the wire. However, cited reference 1 does not teach such hardness deviation of the wire. Specifically, cited reference 1 does not suggest the technical concept that the internal stress of the wire is uniformly distributed by adjusting the hardness deviation of a cross-sectional area of the wire and the hardness deviation in a longitudinal direction of the wire in the wire drawing process. The present invention has no connection with lower hydrogen contents of the wire. As mentioned above, it is clear that the present invention is quite different from cited reference 1 in terms of object, and thus it is obviously impossible even for those skilled in the technical art to which the invention

pertains to anticipate the object of the present invention from the disclosure of cited reference 1.

2. Construction

The present invention provides a wire for arc welding having a hardness deviation of less than 18 between a central portion of a cross section of the wire and a surface of the wire, and a hardness deviation of less than 15 at intervals of 200 mm in a longitudinal direction of the wire when measured by a Vickers hardness tester, which is obtained by a wire drawing process comprising the steps of first drawing, heat treating for releasing the work hardening of the first drawn wire, second drawing, heat treating for removing the internal residual stress of the second drawn wire, and third drawing, wherein the wire passes through first dies having a short bearing and a small reduction contact ratio, i.e., a small contact angle between the wire and the dies, and then second dies having a long bearing and a large reduction contact ratio, i.e., a large contact angle between the wire and the dies. Where are the claim limits of the present claims found in the prior art in substantially the same manner as claimed.

The hardness deviation of the wire is adjustable by controlling a contact area in which the wire is in contact with dies. Specifically, the hardness deviation of the wire is adjustable by adjusting the contact area ratio defined by the following formula. The contact area ration is the sum of a reduction contact ratio and a correction contact ratio. The reduction contact ratio is the ratio of a reduction contact area to cross sectional area of an incoming wire, and the correction contact ratio is the ratio of a correction contact area to a cross sectional area of an outgoing wire. The present invention provides a wire having a contact area ratio of 3 to 3.5.

The method of drawing a wire for arc welding, which comprises the steps of first drawing, heat treating for releasing the work hardening of the first drawn wire, second drawing, heat treating for removing the internal residual stress of the second drawn wire, and third drawing, is characterized in that the third drawing step comprises two

final drawing steps of: reducing a hardness deviation between a central portion of a cross section and a surface of the wire through adjustment of a contact angle of the wire with dies, which is carried out by means of first dies having a short bearing and a small reduction contact ratio, i.e., a small contact angle between the wire and the dies; and reducing a hardness deviation in a longitudinal direction of the wire through adjustment of a length of a bearing part, which is carried out by means of second dies having a long bearing and a large reduction contact ratio, i.e., a large contact angle between the wire and the dies.

The adjustment of the wire according to the present invention is carried out at the final drawing step.

Cited reference 1 provides a process for manufacturing a welding wire having lower hydrogen contents and a smooth outer skin, which is obtained by applying optimum heating in two processes, instead of the conventional single heating, of dehydrogenation heating and outer-skin-softening heating.

Claim 3 of cited reference 1 is as follows:

A process for manufacturing seamless flux-cored welding wire by dehydrogenating a wire prepared by packing flux in a metal tube by heating at a high temperature comprising the steps of directly electrically heating a straight wire 8 to 15 mm in diameter, which comprises a metal tube packed with flux, to a temperature between 620 °C and 1100 °C by passing the wire through a first and a second pairs of roll electrodes spaced 2 to 5 m apart along the path of wire travel and a ring transformer disposed therebetween, cooling the heated wire to a temperature not higher than 500 °C with a coefficient of heat transfer not higher than 250 kcal/m^{2}h °C, and drawing the cooled wire to a diameter between 2 and 7 mm, heating the drawn wire to a temperature between 600 °C and 800 °C, cooling the heated wire to a temperature not higher than 500 °C with a coefficient of heat transfer not higher than 250 kcal/m^{2}h °C, and drawing the cooled wire to a diameter between 0.8 and 4 mm, the weld formed with the welding wire thus obtained containing not more than 3 ml of diffusible hydrogen per 100 g deposited metal.

As can be seen from the disclosure of cited reference 1, dehydrogenation is firstly accomplished by passing the wire at a temperature between 620 °C and 1100 °C through a first and a second pairs of roll electrodes spaced 2 to 5 m apart along the path of wire travel and a ring transformer disposed therebetween. Secondly, outer skin softening annealing of the wire is accomplished by heating the drawn wire to a temperature between 600 °C and 800 °C. It is well known that heat treatment of the wire at a high temperature is required to reduce contents of moisture and other components.

As clearly described in the preferred embodiment of the present invention, the heat treatment of the wire after the wire is firstly drawn is carried out for releasing the work hardening of the first drawn wire, whereas the heat treatment of the wire before the wire is finally drawn is carried out for minimizing and uniformly distributing the internal residual stress of the finally produced wire. The present invention is not applied to the heat treating step of the wire, but to the third drawing step of the wire. The present invention is characterized in that the hardness deviation of a cross section and in a longitudinal direction of the wire is adjusted to the specified range. Consequently, the present invention provides a wire for arc welding having specific ratios in order to accomplish the aforesaid adjustment of the hardness deviation of the wire.

On the other hand, cited reference 1 provides a wire obtained by passing the wire through two pairs of roll electrodes and a ring transformer disposed therebetween. Also, cited reference 1 provides a process for manufacturing the wire comprising the steps of heating and cooling. Cited reference 1 discloses a method for reducing the hydrogen contents of the wire and softening the outer skin of the wire. However, cited reference 1 not only contains no mention of the hardness deviation of the wire, but also it does not teach the method for controlling the hardness deviation of the wire to improve the feeding performance of the wire.

Firstly, the present invention is applied to the third drawing step, whereas cited reference 1 is applied to the heat treatment before drawing the wire and the heat treatment after the first drawing step.

Secondly, cited reference 1 is characterized in that the desired wire is manufactured by heating the wire to a high temperature having a prescribed temperature range, whereas the present invention is characterized in that the desired wire is manufactured by adjusting the hardness deviation of the wire to a specific range in the course of drawing the wire.

Finally, the examiner in charge has the opinion that cited reference 1 discloses the hardness of the outer skin of the wire and the diameter of the wire. However, cited reference 1 does not suggest the hardness deviation of a cross section of the wire and the hardness deviation in a longitudinal direction of the wire. The present invention specifies the hardness deviation between the inner and outer parts of the wire, not at the outer part of the wire. Furthermore, cited reference 1 teaches no equation of hardness deviation, by which the hardness deviation of the wire is defined.

In conclusion, the construction of the wire and the method of manufacturing the wire according to the present invention are quite different from the construction of the wire and the method of manufacturing the wire according to cited reference 1. Cited reference 1 provides a wire manufactured only by heat treatment of the wire, whereas the present invention provides a wire whose hardness deviation is adjusted by limiting the contact area ratio provided for defining the hardness deviation of the wire to be within a specific range. It is obviously impossible even for those skilled in the technical art to which the invention pertains to suggest such a formula for defining the hardness deviation according to the present invention from the heating steps disclosed in cited reference 1.

3. Effect

The present invention has the effect that the reduction contact area is controlled by adjustment of the contact angle of the wire with the dies at the first step, and the correction contact area is controlled to reduce the hardness deviation of a cross section of the wire and the hardness deviation in a longitudinal direction of the wire at the

second step, whereby the residual stress of the wire is uniformly distributed. In this way, it is possible to prevent vibration of the tip of the wire caused by twisting of the wire at the first step, and to prevent defect of welding (bead meandering) caused by bending or twisting of the wire when passing through a cable at the second step.

The present invention shows results of feeding load experiments of the examples of present invention and the comparative examples, which are indicated in Table 1 of the present application. Arc is unstable at the feeding load of approximately 2.1, and welding is possible at the feeding load of over 2.1. However, continuous welding is not possible because of the unstable arc. As indicated in Table 1, examples 1, 2 and 4 have feeding loads of 1.8, 1.5 and 1.7, respectively, which are low. Consequently, the feedability is high and the arc is stable. In case of examples 3 and 5, however, the hardness deviation of a cross section of the wire and the hardness deviation in a longitudinal direction of the wire are out of the preferable range. Specifically, the feeding loads of examples 3 and 5 are 2.2 and 2.1, respectively, which are high. In other cases that the hardness deviation of a cross section of the wire and the hardness deviation in a longitudinal direction of the wire are out of the preferable range, the feeding loads are over 2.1 with the result that the arc is unstable.

In brief, the present invention specifies the hardness deviation of the wire, by which the wire having uniformly distributed residual stress and enhanced feedability can be manufactured.

Cited reference 1 provides a wire having lower hydrogen contents and a uniform and smooth surface, which is obtained by the aforesaid heat treatment. Especially, cited reference 1 provides a wire containing not more than 3 ml or not more than 5 ml of diffusible hydrogen in 100 g deposited metal. Hydrogen contents are reduced by heat treatment at a high temperature, and outer skin softening annealing of the wire is carried out so that the wire has a uniform and smooth surface, whereby contents of moisture are reduced.

As can be seen from the above-mentioned comparison between the present invention and cited reference 1, the present invention is also quite different from cited

reference 1 in terms of effect. Cited reference 1 does not disclose or suggest the effect of the uniform residual stress of the welding wire according to the present invention. Furthermore, the present invention has a considerable effect in that the feeding load is reduced only by the drawing step of the wire in the course of a final drawing process while not being subjected to heat treatment as in cited reference 1. The aforesaid effects of the present invention cannot be anticipated from the disclosure of cited reference 1, and thus the present invention has excellent effects as compared to cited reference 1.

4. Conclusion

As mentioned above, the present invention is quite different from cited reference 1 in terms of object and construction. Furthermore, the present invention has the effect different from cited reference 1 since the construction of the present invention is different from that of cited reference 1. Cited reference 1 merely suggests the hardness of the outer skin of the wire. Cited reference 1 does not teach the hardness deviation of a cross section of the wire and the hardness deviation in a longitudinal direction of the wire. Consequently, it is obviously impossible even for those skilled in the technical art to which the invention pertains to specify the inner hardness deviation of the wire with the outer hardness of the wire and anticipate the contact area ratio by which the hardness deviation is limited, and therefore it is obvious that the present invention is not easily anticipated from the disclosure of cited reference 1. Accordingly, it is most respectfully requested that this rejection be withdrawn.

In view of the above comments, favorable reconsideration and allowance of all of the claims now present in the application are most respectfully requested.

Respectfully submitted,

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